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Gray et al.

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[54] **SOLENOID FOR ELECTRIC STARTERS**

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[73] Assignee: **General Motors Corporation,** Detroit, Mich.

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[51] **Int. Cl.**[4] **H01H 67/02**

[52] **U.S. Cl.** **335/131;** 335/126

[58] **Field of Search** 335/126, 131, 202, 255, 335/83

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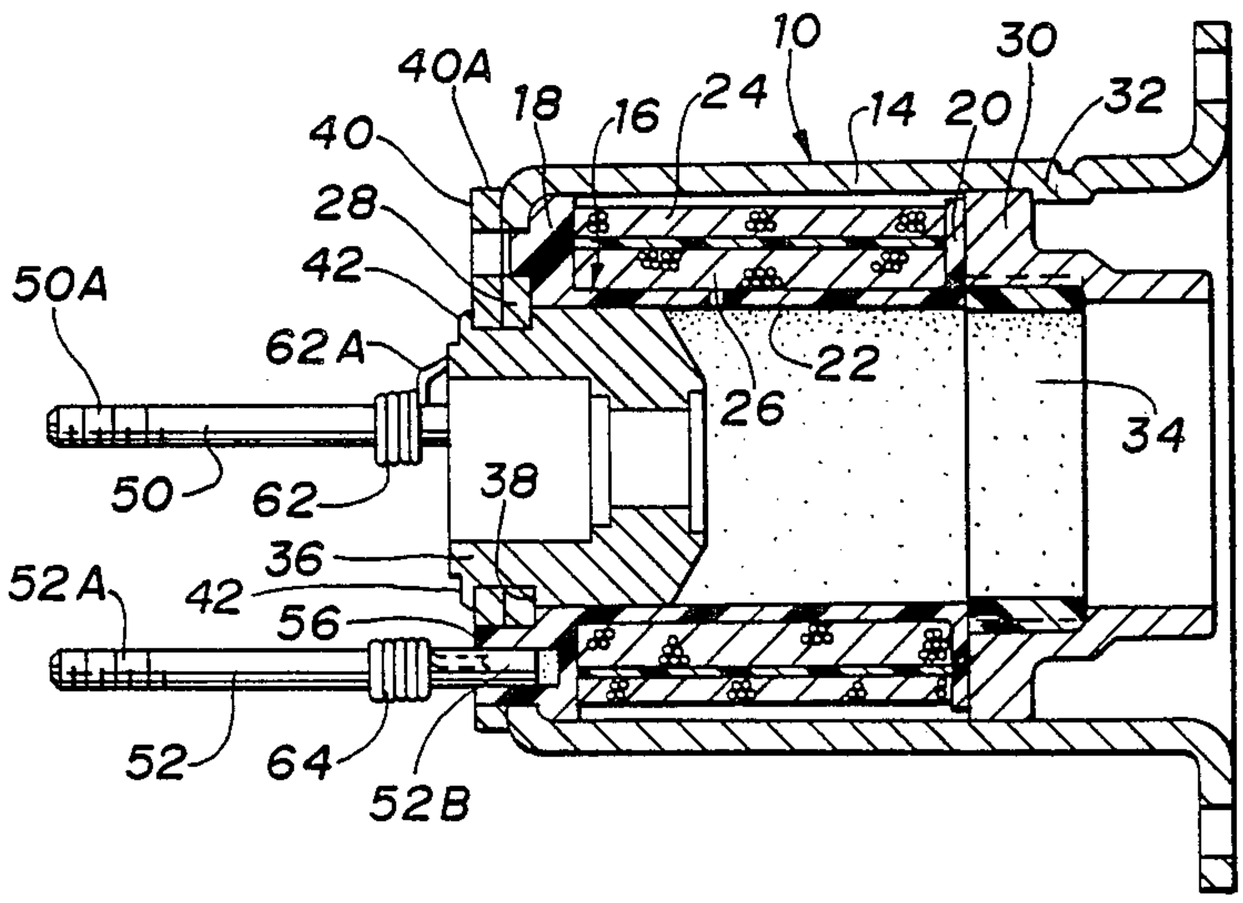
[57] **ABSTRACT**

A solenoid for an electric starter. The solenoid has a metal case that contains a coil winding assembly. The coil winding assembly includes a plastic coil spool that carries a pull-in coil and a hold-in coil. One end of the coil spool supports a plurality of axially extending metallic threaded studs that are insert molded into the end of the coil spool. The end leads of the coils are wrapped around the studs and welded thereto. The studs, together with nuts that are threaded onto the threaded portions of studs, serve to secure a plastic cover to an end of the metal case.

3 Claims, 1 Drawing Sheet



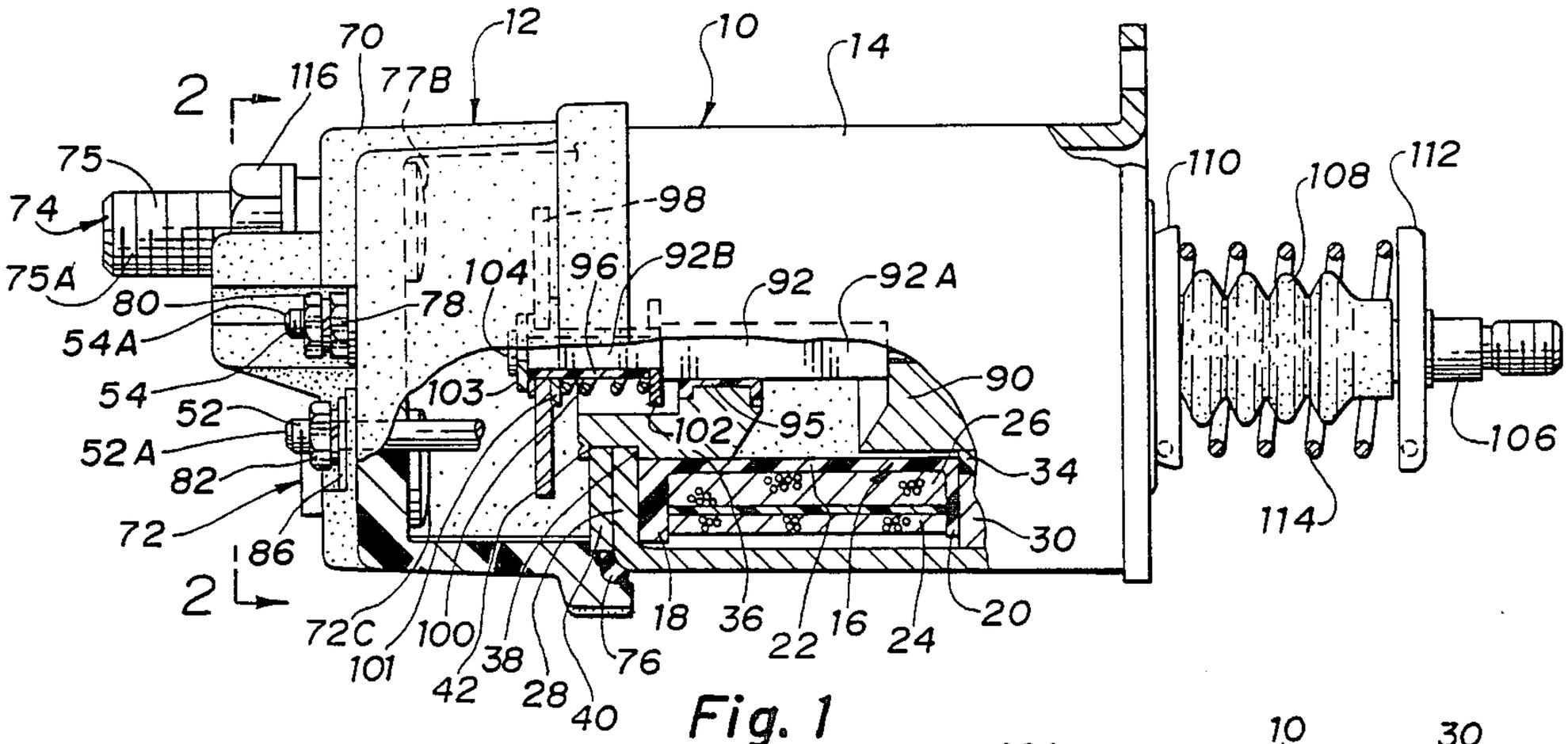


Fig. 1

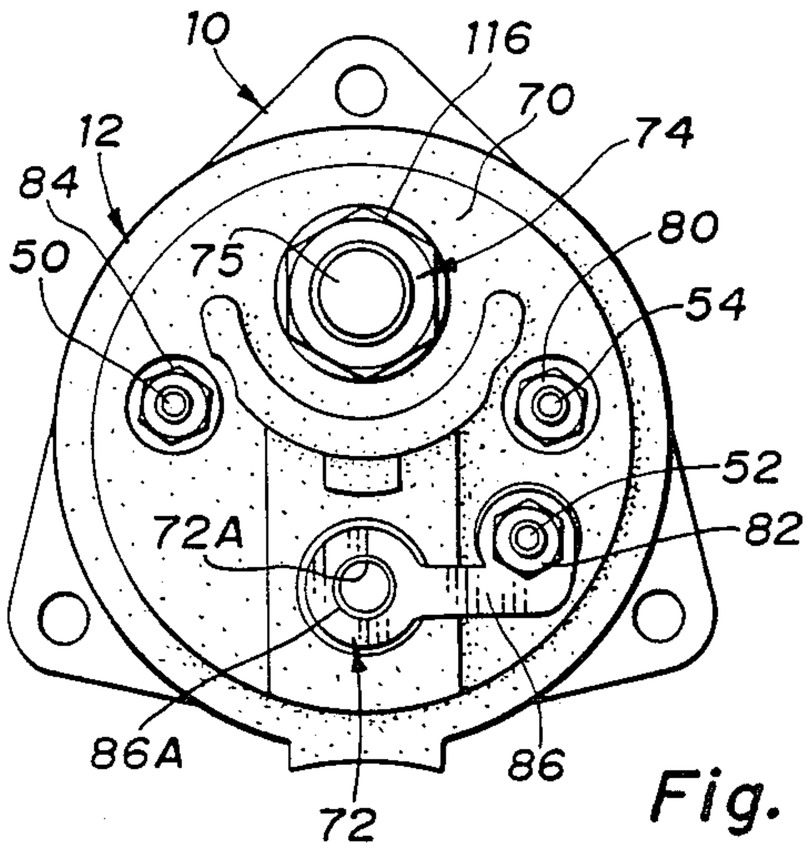


Fig. 2

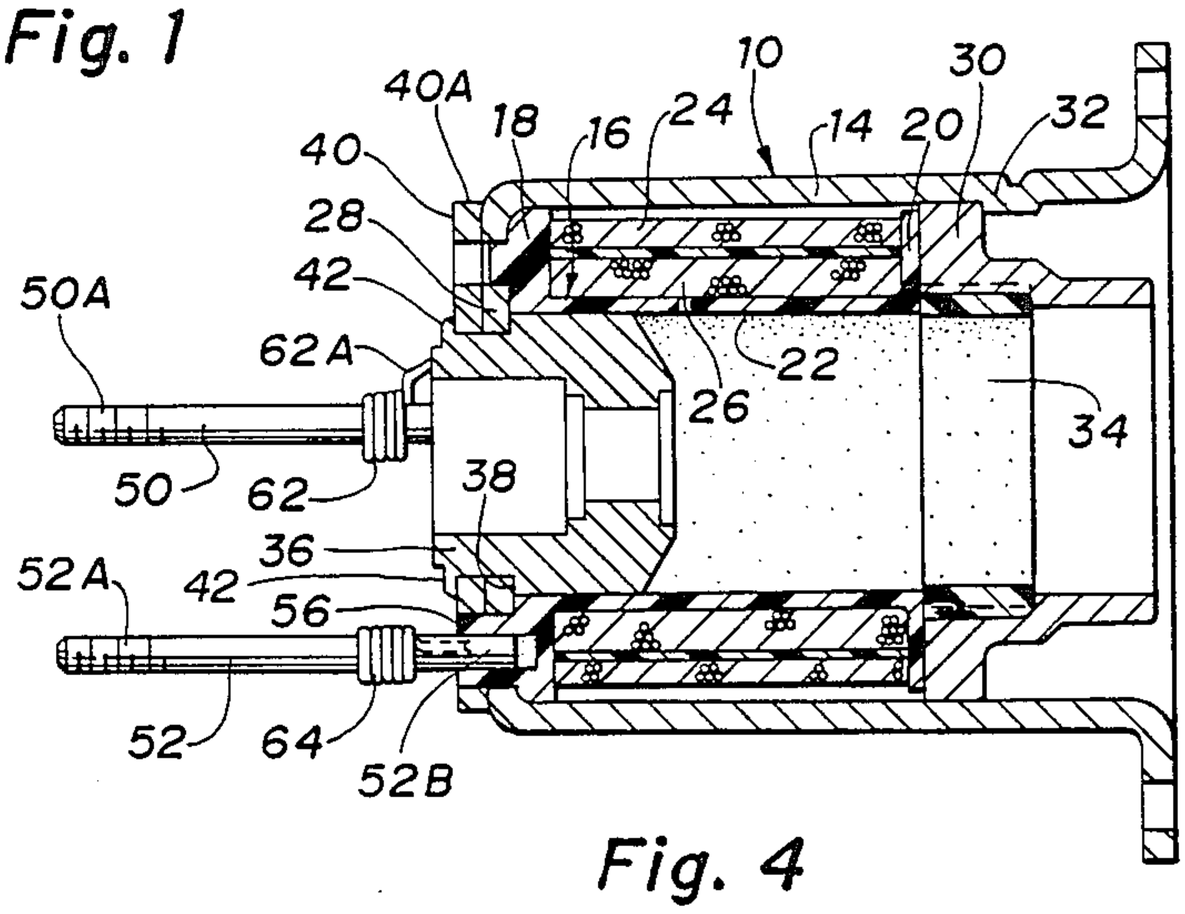


Fig. 4

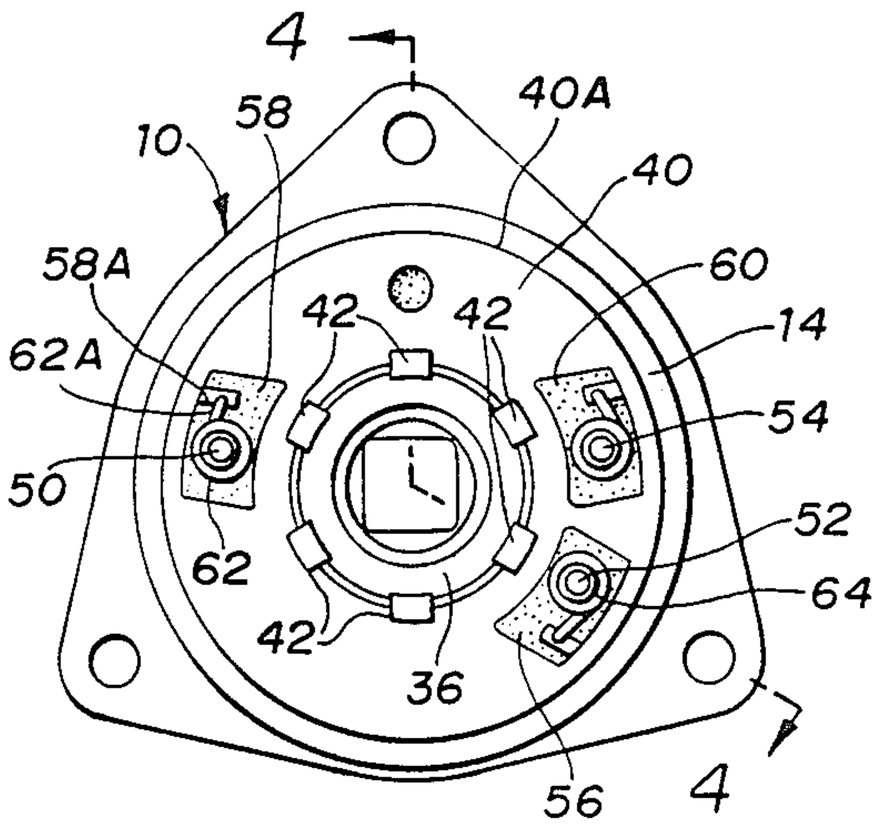


Fig. 3

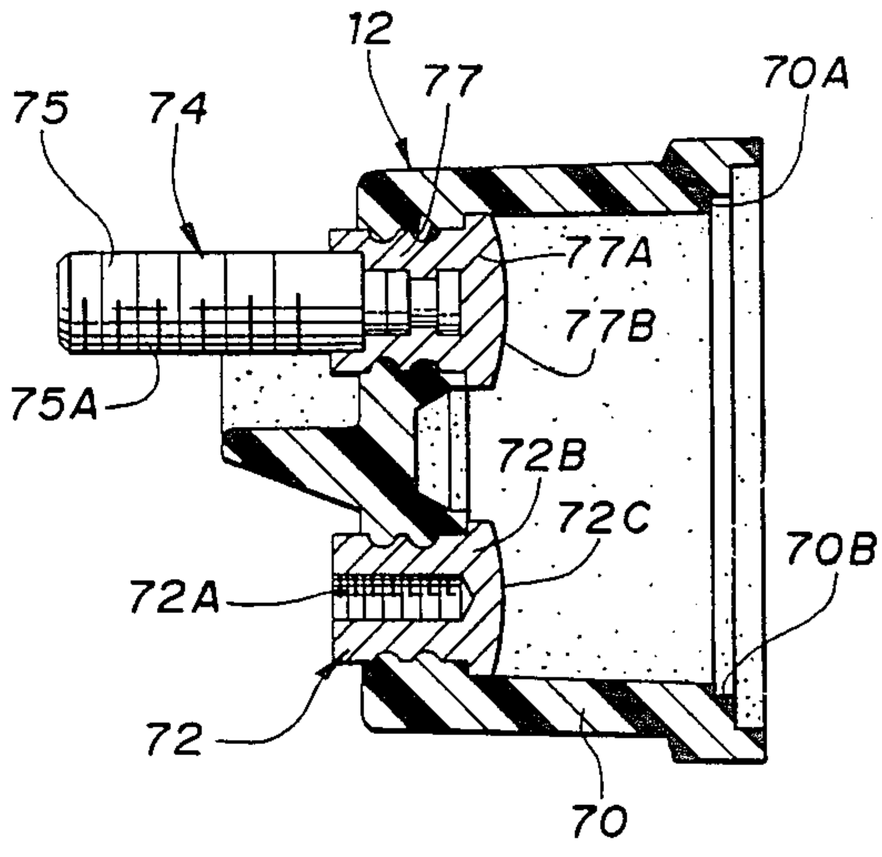


Fig. 5

SOLENOID FOR ELECTRIC STARTERS

This invention relates to solenoids and more particularly to solenoids for an electric starter.

Solenoids for electric starters that have a case and coil assembly and a cover assembly that is secured to the case and coil assembly are well known to those skilled in the art. Examples of such solenoids are disclosed in the U.S. patents to Gresley et al. 4,540,962 and to Colvin et al. 4,382,242. In the solenoids of the type described, some means must be provided to secure the cover assembly to the case and coil assembly. In the Colvin et al. patent this is accomplished by the use of cover retention screws that are threaded into mounting studs that are supported by a steel plate. In the Gresley et al. patent the case and cover are secured together by forming a portion of the case over a surface of the cover.

It is also known to use fasteners to form electrical connections between the interior and exterior of a solenoid housing where the fasteners also perform some fastening function. Thus, the United States patent to Ray 3,134.932 discloses so-called binding posts which connect the interior and exterior of a solenoid housing and which further serve to fasten a strip of insulation in place. The binding posts of Ray are not insert molded into the coil spool. It is further known to provide the fastener arrangement shown in the Ray patent to secure a cover of a starter solenoid to a case and coil assembly where the fasteners also provide electrical connections between the interior and exterior of a solenoid. This invention, like the prior art mentioned above, provides a fastening means for securing the cover to the case which also serves as an electrical connector means for forming an electrical connection between the coil or coils of the solenoid and the exterior of the cover. However, the solenoid of this invention differs from the above-mentioned prior art in that the fastening means is insert molded into the coil spool. Thus, the solenoid of this invention has a coil assembly wherein a plastic coil spool carries one or more coil windings and a plurality of metallic threaded terminal studs that are insert molded into the spool. The end leads of the solenoid coil or coils are wrapped around the studs and welded thereto. The cover is attached to the case by passing the studs through openings in the cover and then applying nuts to the threaded portions of the studs to thereby tightly fasten the cover to the case. The studs accordingly operate as electrical connectors and as a fastening means for securing the cover to the case.

Another object of this invention is to provide a solenoid of the type described that has a steel end plate that provides a flux path and a register for the solenoid cover.

IN THE DRAWINGS

FIG. **1** is a side view with parts broken away of a starter solenoid made in accordance with this invention;

FIG. **2** is an end view of the solenoid shown in FIG. **1** looking in the direction of arrows **2—2**;

FIG. **3** is an end view of a case and coil assembly that forms a part of the solenoid shown in FIG. **1**;

FIG. **4** is a sectional view taken along line **4—4** of FIG. **3**; and

FIG. **5** is a sectional view of a cover assembly which is utilized in the solenoid shown in FIG. **1**.

Referring now to the drawings, and more particularly to FIG. **1**, a starter solenoid is illustrated that has a case and coil assembly **10**. The case and coil assembly **10** is secured to a cover assembly **12** in a manner that will be described.

The case and coil assembly **10** comprises a tubular steel case **14**. The case **14** supports a coil winding assembly which is comprised of a spool or coil winding support **16** that is formed of plastic insulating material. The coil support **16** has flanges **18** and **20** and a tubular portion **22**. The spool or coil winding support **16** carries a hold-in coil **24** and a pull-in coil **26** which are comprised of a number of turns of wire.

The coil winding assembly is clamped between an end wall **28** of case **14** and a steel end plate **30**. The end plate **30** is secured to the case **14** by staking in portions of the case **14**. One of the staked in portions is shown and designated by reference numeral **32**. The end plate **30** carries a bearing bushing **34**, which as will be more fully described hereinafter, slidably supports the armature or plunger of the solenoid. The bushing **34** is formed of a plastic bearing material such as nylon. The case and coil assembly **10** further includes a steel plunger stop **36**. The plunger stop has an annular surface **38** which engages a portion of the case **14**. A steel end plate **40** engages the plunger stop **36** and a portion of case **14**. The end plate **40** has a circular outer surface **40A**. Since the plate **40** is formed of magnetic material it provides a path for flux that is developed when coils **24** and **26** are energized. The plunger stop **36** is staked-in over areas designated as **42** to thereby secure the plunger stop **36** and plate **40** to an end of case **14**.

The case and coil assembly **10** has three steel terminal studs designated respectively by reference numerals **50**, **52** and **54**. Each terminal stud has a threaded portion **50A**, **52A** and **54A**. All of these studs have one end thereof molded into portions of the coil spool **16** so that the studs are supported by the spool. As can be seen in FIG. **4**, the end **52B** of terminal stud **52** is insert molded into portion **56** of spool **16**. In a similar fashion, the ends of terminal studs **50** and **54** are insert molded into portions **58** and **60** of spool **16**. The portions **56**, **58** and **60** of spool **16** extend through openings formed in the end plate **40** and in the end wall **28** of case **14**.

As will be more fully described hereinafter the terminal studs **50**, **52** and **54** serve to secure the cover assembly **12** to the case **10** and also serve to form electrical connections or terminations for the pull-in and hold-in coils **26** and **24**. Thus, one end lead or terminating conductor of the hold-in coil **24** is electrically connected to stud **50**. This is shown in FIG. **4** where a terminating end of hold-in coil **24** is shown wrapped around a portion of terminal stud **50**. This wrapped around portion is designated by reference numeral **62** and the wrapped coils **62** are welded to terminal stud **50**. The lead **62A** that is the end or terminating lead of one side of hold-in coil **24** extends through a slot **58A**. The conductor portion **62** that is welded to terminal stud **50** may be for example the outside lead of the hold-in coil **24**. In a similar fashion, the outside end lead of the pull-in coil **26** is electrically connected to terminal stud **52** by wrapping the end of this lead around terminal stud **52** and welding this portion to the terminal stud **52**. The welded coil portion just referred to is designated by reference numeral **64**.

The terminal stud **54** is electrically connected to the inside lead end of the pull-in coil **26** and to the inside lead end of the hold-in coil **24** by wrapping the end

leads around terminal stud **54** and welding these portions to the terminal stud **54** in a manner that has been described in connection with the welding of wrapped coils to the terminal studs **50** and **52**.

The terminal stud **54** may be termed a switch terminal stud since in use on a starter it will be electrically connected to a starting switch. The terminal stud **52** may be termed a motor terminal stud since it is electrically connected to the cranking motor when the solenoid is attached to an electric starter. The terminal stud **50** may be termed a return terminal stud.

Referring now to FIG. **5**, the cover assembly **12** comprises a cover member **70** which is formed of a plastic insulating material. The cover **70** has annular surfaces **70A** and **70B**. The cover **70** carries a motor terminal **72** and a battery terminal generally designated by reference numeral **74**. The battery terminal **74** is comprised of a steel threaded terminal stud **75** which is secured to a copper part **77**. This is accomplished by molding one end of steel stud **75** into copper part **77**. The stud **75** has a threaded portion **75A**. The copper terminal **72** and part **77** are insert molded into the plastic cover **70**. The terminal **72** has a threaded bore **72A** for receiving a threaded stud. The terminal **72** has a contact portion **72B** that has a contact face **72C**. Part **77** has a contact portion **77A** that has a contact face **77B**. The contact faces **72C** and **77B** are adapted to be engaged by a movable electrical contact in a manner that will be described. The contact portions **77A** and **72B** have a rectangular or square outline to prevent them from turning.

The manner in which the cover assembly **12** is secured to the case **14** will now be described. When it is desired to secure the cover assembly **12** to the case **14** the terminal studs **50, 52** and **54** are passed through openings in the cover **70** so that the threaded portions of the studs project beyond the outer end surface of the cover **70**. During this assembly a rubber **0**-ring **76** is assembled such that it engages the outer surface **40A** of plate **40** and a curved surface of case **14**. With the parts in the position described, nuts **78** and **80** are threaded onto stud **54**, a nut **82** is threaded onto stud **52** and a nut **84** is threaded onto stud **50**. When these nuts are tightened the cover **70** is tightly secured to the case **14** and the **0**-ring **76** is compressed. In securing the nuts to the studs, suitable steel and insulating washers are used. When the cover **70** is assembled to case **14** the surface **70B** of cover **70** and outer surface **40A** of plate **40** form register surfaces. Thus, the plate **40** operates as a register for cover **70**.

It should be noted that before the nut **82** is threaded onto the terminal stud **52**, a copper connector strap **86** is assembled to stud **52**. The connector strap **86** has a hole or opening that receives the terminal stud **52** and has another opening **86A** which is aligned with the threaded bore **72A** of motor terminal **72**. The connector strap **86** therefore serves to electrically connect the motor terminal **72** and the terminal stud **52**. The connector strap **86** is held in the position shown in FIG. **2** by nut **82** when it is tightened.

The solenoid shown in FIG. **1** has a plunger or armature **90** which is formed of a magnetic material such as steel. The plunger **90** is secured to a steel plunger shaft **92**. The shaft **92** has portions **92A** and **92B** which have a square or rectangular outline. The portion **92A** slides in a bushing **95** which is formed of a plastic bearing material such as nylon. The bushing **95** is a snap-in type of bushing and is supported by central bore surfaces of plunger stop **36**. The internal bore configuration of bushing **95** is square or rectangular to prevent turning or rotation of portion **92A** of shaft **92**.

The portion **92B** of shaft **92** carries a part **96** that is formed of plastic insulating material. The portion **92B** has a square or rectangular outline which cooperates with a square or rectangular bore of the insulator part **96** to prevent part **96** from rotating or turning relative to portion **92B**.

The insulator **96** carries a movable contact or contactor **98** which is formed of copper. The contact **98** has a square or rectangular opening that is complementary to a square or rectangular outer surface of insulator **96** to thereby prevent contact **98** from turning or rotating relative to insulator **96**.

The contact **98** is forced against a radial flange of insulator **96** by an overtravel spring **100** that is compressed between an insulating washer **101** and a steel washer **102**. A steel washer **103** is located between an end of insulator **96** and a spun-over portion **104** of shaft **92**.

The plunger **90** is secured to another shaft **106** that is adapted to be connected to a shift lever mechanism of an electric starter for shifting the pinion. The shaft **106** is enclosed by a rubber boot **108**. The shaft **106** carries a pair of retaining rings **110** and **112** and a spring **114** is interposed between these rings.

It will be appreciated that contact **98** and contacts **77A** and **72B** form a switch means. Contacts **77A** and **72B** are the fixed contacts of the switch and contact **98** is the movable contact. When plunger **90** is moved b energization of coils **24** and **26** the contact **98** will be moved into engagement with contact faces **77B** and **72C** to thereby electrically connect terminals **74** and **72**. The contact **98** preferably has a rectangular outer configuration and is dimensioned such that it will not engage studs **50, 52** and **54** when it is moved. Putting it another way, there is clearance between the outer marginal edge of contact **98** and the studs. The plunger **90** slides in the bushing **34** and is supported thereby.

When the solenoid is assembled to a cranking motor to provide a complete electric starter the shaft **106** is connected to a shift lever mechanism for shifting the pinion of the starter. The motor terminal **72** is connected to the cranking motor by a strap type of conductor (not illustrated) that has a hole or opening that is aligned with the threaded bore **72A**. A threaded stud is now used to secure the strap to terminal **72** with the strap engaging the part of connector **86** that surrounds opening **86A**. The stud **75** is adapted to project through an eyelet terminal of a battery cable and to be held in place by a nut **116** that is threaded onto threaded portion **75A** of stud **75**.

At the expense of some reiteration, it is pointed out that the steel plate **40** acts as a flux path and also as a register for cover **70**. This provides good sealing alignment for the **0**-ring seal **76** and also provides cover rigidity. In regard to the register aspect, it is seen that surface **70B** of cover **70** fits over the outer circular surface **40A** of plate **40**. Surface **70A** abuts an annular surface portion of plate **40**. By way of example, and not by way of limitation, the outer diameter of surface **40A** may be about 64.9 to 65.1 mm and the inner diameter of annular surface **70B** about 65.2 to 65.4 mm.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A solenoid switch comprising, a tubular case, a coil support formed of electrical insulating material dis-

posed within said case, at least one coil winding carried by said coil support, a plurality of metallic studs each having an end portion that is insert molded into said coil support whereby said studs are rigidly supported by said coil support, each stud having a threaded portion, a cover formed of electrical insulating material, said studs extending through openings in said cover with the threaded portions of the studs positioned exterior of the cover, nut means threaded onto the threaded portions of said studs for securing said cover to said case, a plunger shiftable relative to said coil support, switch means including movable contact means disposed within said cover and actuated by said plunger, and means electrically connecting an end lead of said coil winding to one of said studs at a point located within said cover.

2. A solenoid switch for an electric starter comprising, a tubular case formed of magnetic material, a coil support formed of electrical insulating material disposed within said case, a pull-in coil and a hold-in coil carried by said coil support, a plurality of metallic studs each having an end portion that is insert molded into said coil support whereby said studs are rigidly supported by said coil support, each stud having a threaded portion, a cover formed of electrical insulating material, said studs extending through openings in said cover with the threaded portions of the studs positioned exterior of the cover, nut means threaded onto the threaded portions of said studs for securing said cover to said case, a plunger shiftable relative to said coil support, switch means including movable contact means disposed within said cover and actuated by said plunger, and means electrically connecting end leads of said pull-in and hold-in coils to said studs at points located within said cover.

3. The solenoid according to claim 2 where the tubular case has an end wall and a plate formed of magnetic material that engages an outer surface of said end wall and is secured to said case, the plate having a circular outer marginal surface and wherein said cover has an inner circular surface that is located adjacent said circular outer marginal surface of said plate, and an 0-ring formed of elastomeric material compressed between said cover and case and disposed about said outer marginal surface of said plate, said plate providing a flux path for flux generated when said coils are energized.

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